FLUORSPAR

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Fluorspar is used directly or indirectly to manufacture such products as aluminum, gasoline, insulating foams, plastics, refrigerants, steel, and uranium fuel. Most fluorspar consumption and trade involve either acid grade (also called acidspar), which is greater than 97% calcium fluoride (CaF_2), or subacid grade, which is 97% or less CaF_2. Subacid grade includes metallurgical and ceramic grades, and is commonly called metallurgical grade or metspar. The bulk of U.S. demand is supplied by imports, although supply is supplemented by sales of material from the National Defense Stockpile (NDS) and by small amounts of byproduct synthetic fluorspar produced from industrial waste streams. Byproduct fluorosilicic acid production from some phosphoric acid producers supplements fluorspar as a domestic source of fluorine but is not included in fluorspar production or consumption calculations. According to the U.S. Census Bureau, U.S. imports of fluorspar increased by nearly 6%, imports of hydrofluoric acid (HF) increased by 15%, and exports of fluorspar decreased by nearly 33% when compared with those in 2003.

Legislation and Government Programs

During calendar year 2004, the Defense National Stockpile Center (DNSC) reported no sales of fluorspar from the NDS. According to the DNSC's fiscal year 2005 (October 1, 2004, to September 30, 2005) Annual Materials Plan, total sales of about 54,400 metric tons (t) (60,000 short dry tons) of metallurgical grade and 10,900 t (12,000 short dry tons) of acid grade have been authorized. Actual quantities sold will be limited to remaining sales authority or inventory. Unsold quantities that remain in the NDS are documented in the "Stocks" section of this report.

Production

In 2004, there was no reported mine production of fluorspar in the United States. There are no U.S. Geological Survey (USGS) data survey for synthetic fluorspar. Fluorosilicic acid is produced as a byproduct from the processing of phosphate rock into phosphoric acid. Domestic production data for fluorosilicic acid were developed by the USGS from a voluntary canvass of U.S. operations. Of the seven fluorosilicic acid operations surveyed, all reported production, representing 100% of the quantity reported.

Fluorosilicic acid is a byproduct of the phosphate fertilizer industry. In 2004, IMC Global Inc. and Cargill Fertilizer, LLC merged to form a new company called The Mosaic Company (Mosaic Company, The, 2004§[1]). The fertilizer operations of this new company were named Mosaic Fertilizer, LLC. This merger reduced to three the number of companies producing marketable byproduct fluorosilicic acid at phosphoric acid plants (part of a phosphate fertilizer operation). In addition to Mosaic Fertilizer, PCS Phosphate Co., Inc. and U.S. Agri-Chemicals Corp. produced fluorosilicic acid. These three companies operated seven plants and reported production of 50,900 t of byproduct fluorosilicic acid. They sold or used 51,000 t of byproduct fluorosilicic acid (equivalent to approximately 89,800 t of fluorspar grading 92% CaF_2). This material was valued at about $7.86 million. Because fluorosilicic acid is a byproduct of the phosphate fertilizer industry and is not manufactured for itself alone, shortages may occur when phosphate fertilizer production decreases.

Some synthetic fluorspar was recovered as a byproduct of uranium processing, petroleum alkylation, and stainless steel pickling. The majority of the marketable product was estimated to come from uranium processing, but the actual amount of synthetic fluorspar recovered is unknown.

Hastie Mining Co. in Cave-In-Rock, IL, Oxbow Carbon and Minerals LLC in Aurora, IN, and Seaforth Mineral & Ore Co., Inc. in East Liverpool, OH, screened and dried metallurgical- and acid-grade fluorspar. These materials were either purchased from the NDS in prior years or imported from Mexico.

Environment

In the United States, fluoride is added to drinking water in many localities in order to reduce dental caries (cavities). In 1986, the U.S. Environmental Protection Agency (EPA) set a maximum contaminant level (MCL) of fluoride at 4 milligrams per liter (mg/L) in drinking water and set a secondary MCL at 2 mg/L. The secondary MCL is a goal that water systems should try to reach, but they cannot be fined if they fail to do so. Recent evidence from human and animal studies indicated that excessive levels of fluoride present risks to bones and other organs. As a result of this new research, the EPA requested the National Research Council (NRC) of the National Academies to perform another review of the potential problems associated with water fluoridation. The specific task for the new NRC review was to examine the toxicological, epidemiological, clinical, and exposure data published on fluoride since 1993. The original study was begun in November 2002, and the project was to conclude after 24 months with a final report on the study to

[1]References that include a section mark (§) are found in the Internet References Cited section.

be issued at its conclusion. The project has been extended twice and is now scheduled for completion in February 2006 (National Research Council, 2003§).

Consumption

Domestic consumption data for fluorspar were developed by the USGS from a quarterly consumption survey of three large consumers that provide data on HF and aluminum fluoride (AlF_3) consumption and four distributors that provide data on the merchant market (metallurgical and other uses). Quarterly data were received from all seven respondents, and these responses accounted for 100% of the reported consumption in table 2.

Industry practice has established three grades of fluorspar—acid grade, containing more than 97% CaF_2; ceramic grade, containing 85% to 95% CaF_2; and metallurgical grade, normally containing 60% to 85% CaF_2. Fluorspar grades are defined by the intended use, but these grades are essentially just averages. During the past several decades, there has been a general movement in the United States toward the use of higher quality fluorspar by many of the consuming industries. For example, welding rod manufacturers may use acid-grade fluorspar rather than ceramic grade, and some steel mills use ceramic or acid grade rather than metallurgical grade.

Total reported U.S. fluorspar consumption increased by more than 9% in 2004 compared with that of 2003. Consumption of acid grade for HF and AlF_3 increased by 12% to 586,000 t, but consumption of fluorspar for metallurgical and other uses decreased by 7% (table 2).

Acid-grade fluorspar was used primarily as a feedstock in the manufacture of HF. Two companies reported fluorspar consumption for the production of HF—E.I. du Pont de Nemours & Co. Inc. (DuPont) and Honeywell International Inc. The following is a discussion of HF markets; most acid-grade fluorspar is converted to HF before consumption. In 2004, production of HF for use in manufacturing fluorocarbons accounted for the bulk of the increased consumption of acid-grade fluorspar.

The leading use of HF was for the production of a wide range of fluorocarbon chemicals, including hydrofluorocarbons (HFCs), hydrochlorofluorocarbons (HCFCs), and fluoroelastomers or fluoropolymers. HCFCs and HFCs were produced by Arkema Inc. (formerly ATOFINA Chemicals Inc.), DuPont, Great Lakes Chemical Corp., Honeywell, INEOS Fluor Americas LLC, MDA Manufacturing Ltd., and Solvay Solexis Inc.

Some of the existing or potential fluorocarbon replacements for banned chlorofluorocarbons (CFCs) are HCFCs 22, 123, 124, 142b, and 225. These HCFC substitutes have ozone-depletion potentials that are much lower than those of CFCs 11, 12, and 113, which together had accounted for more than 90% of CFC consumption prior to their phaseout. Specific HCFCs individually or in mixtures are being used in home air conditioning systems, in chillers, as foam blowing agents, as solvents (in addition to perfluorocarbons and hydrofluoroethers), and as a diluent in sterilizing gas.

The HFC replacements have no ozone-depletion potential because they contain no chlorine atoms. The most successful HFC replacement compound is HFC 134a. It is the main replacement for CFC 12 in automobile air conditioners and is being used as the refrigerant in new commercial chillers and refrigerators and as the propellant in aerosols and tire inflators. HFCs 23, 32, 125, 143a, 152a, 227ea, 236fa, 245fa, and 4310 also are being produced domestically but in much smaller quantities. These HFCs are being used individually or in blends as replacements for CFCs and HCFCs.

In the foam blowing market, HFCs 134a, 152a, 245fa, and 365mfc are the primary compounds that have replaced banned CFCs and HCFCs. For blowing polyurethane, the primary fluorocarbon blowing agents are HFCs 134a, 245fa, and 365mfc. Honeywell manufactured and marketed HFC 245fa for this market from its plant in Louisiana. HFC 245fa was also being marketed as a replacement for HCFCs 22 and 123 in low-pressure centrifugal chillers. HFC 365mfc has not been approved for foam blowing in the United States, but Solvay Fluor (a business unit of Solvay S.A.) manufactured it at its plant in France for the European market. HFC 152a has been approved for use in several types of foams but is primarily used for blowing polystyrene and polyolefin foams.

HCFCs 22, 123, and 124; HFCs 23, 125, 134a, and 227ea; and a number of other fluorine compounds have been approved by the EPA as acceptable substitutes (some subject to use restrictions) for halon 1211 as a streaming agent and for halon 1301 as a total flooding agent for fire suppression. Although the production of halons has been banned in the United States since 1993, the use of recycled halon material is allowed. The availability of ample supplies of recycled halons has slowed the substitution of more ozone-friendly compounds.

The use of HF for the manufacture of fluoroelastomers and fluoropolymers continued to display strong growth. CFC 113, HCFCs 22 and 142b, and HFC 152a were produced as chemical intermediates in the production of fluoroelastomers and fluoropolymers. These compounds have desirable physical and chemical properties that allow them to be used in products that include pipes, valves, seals, architectural coatings, and cookware. These intermediate uses of CFC 113 and HCFCs 22 and 142b will not be subject to the production phaseouts mandated by the Montreal Protocol on Substances that Deplete the Ozone Layer and the Clean Air Act Amendments of 1990 because these products are consumed in the manufacturing process.

HF was consumed in the manufacture of uranium tetrafluoride, which was used in the process of concentrating uranium isotope 235 for use as nuclear fuel and in fission explosives. It also was used in glass etching, petroleum alkylation, stainless steel pickling, and treatment of oil and gas wells and as a cleaner and etcher in the electronics industry. HF was used as the feedstock in the manufacture of a group of inorganic fluorine chemicals that include chlorine trifluoride, lithium fluoride, sodium fluoride, stannous fluoride, sulfur hexafluoride, tungsten hexafluoride, and others that are used in decay-preventing dentifrices, dielectrics, metallurgy, mouthwashes, water fluoridation, and wood preservatives. It was used as the feedstock for producing potassium fluoride, which is the preferred fluorine source in a number of insecticides and herbicides, and in some proprietary analgesic preparations, antibiotics, and antidepressants.

Acid-grade fluorspar was used in the production of AlF_3 and cryolite (Na_3AlF_6), which are the main fluorine compounds used in aluminum smelting. In the Hall-Héroult aluminum process, alumina is dissolved in a bath that consists primarily of molten Na_3AlF_6,

AlF_3, and fluorspar to allow electrolytic recovery of aluminum. In countries with strong environmental regulations, a modern aluminum smelter that uses prebaked anode technology will contain high-efficiency scrubbers that will recover 96% to 99% of fluorine emissions. Fluorine losses are made up entirely by the addition of AlF_3, the majority of which will react with excess sodium from the alumina to form Na_3AlF_6. This type of smelter will consume about 20 kilograms (kg) of AlF_3 for each metric ton of aluminum produced. Plants that use the older Soderburg technology with minimal recovery of fluorine emissions will have significant losses of fluorine and sodium, which will be replaced by adding a combined 40 to 50 kg of AlF_3 and Na_3AlF_6 per ton of aluminum produced.

Minor uses of AlF_3 included its use by the ceramics industry for some body and glaze mixtures, in the production of specialty refractory products, in the manufacture of aluminum silicates, in the glass industry as a filler, as a catalyst for organic synthesis, and as an inhibitor of fermentation.

Most AlF_3 is produced directly from acid-grade fluorspar or from byproduct fluorosilicic acid. In 2004, Alcoa World Alumina LLC (a business unit of Alcoa Inc.) produced AlF_3 from fluorspar at Point Comfort, TX.

The merchant fluorspar market in the United States includes metallurgical- and acid-grade sales mainly to steel mills, but also includes smaller markets, such as cement plants, foundries, glass and ceramics plants, and welding rod manufacturers in rail car, truckload, and less-than truckload quantities. In 2004, this merchant market totaled 86,100 t, which included 46,800 t of acid-grade sales (54% of the merchant market) and 39,400 t of metallurgical-grade sales (46% of the merchant market). During the past 20 to 30 years, fluorspar usage in such industries as steel and glass has declined because of product substitutions or changes in industry practices.

Acid- or ceramic-grade fluorspar was used by the ceramics industry as a flux and an opacifier in the production of flint glass, white or opal glass, and enamels. These grades also were used in welding fluxes and as a flux in the steel industry. In welding, fluxes are commercially termed “welding consumables” and are manufactured as a flux coating to electrodes, as a flux core in a wire electrode, or as powdered flux product. These products are broadly categorized as “acid,” “basic,” “rutile,” and “cellulosic.” Fluorspar is used in basic compositions where it can make up from 30% to 40% of the flux composition (O’Driscoll, 2002).

Metallurgical-grade fluorspar was used primarily as a fluxing agent by the steel industry, frequently in stainless steel production. Fluorspar is added to the slag to make it more reactive by increasing its fluidity (by reducing its melting point), which also helps avoid crust formation. Reducing the melting point of the slag brings lime and other fluxes into solution to allow the absorption of impurities. Fluorspar of different grades was used in the manufacture of aluminum, brick, and glass fibers and by the foundry industry in the melt shop.

In the United States, consumption of fluorspar in metallurgical markets (mainly steel) decreased by 6% compared with that of 2003. Internationally, supplies of metallurgical-grade fluorspar were tight because world steel production increased and because in recent years China has reduced its metspar exports dramatically. The leading supplier, Mexico’s Cia. Minera Las Cuevas S.A. de C.V., was sold out, and the only other major exporter of metallurgical grade was Mongolia, which exported most of its metallurgical grade to Russia.

Metallurgical- or submetallurgical-grade fluorspar is used in cement production where it acts mainly as a flux. It is added to the mix of cement raw materials before introduction to the rotary kiln. The addition of fluorspar provides a savings in thermal energy by allowing the kiln to operate at a lower temperature, thus saving fuel. It also increases the amount of tricalcium silicate produced. More tricalcium silicate results in a softer clinker product, which requires less grinding time, thus saving electrical energy. Its use can, however, damage the refractory lining in the cement kiln and this factor has limited its use in the cement industry.

About 38,700 t of byproduct fluorosilicic acid valued at $5.15 million was sold for water fluoridation, and about 12,300 t valued at $2.71 million was sold or used for other uses. There were no sales for AlF_3 production in 2004.

Stocks

Data for stocks were available from distributors and HF and AlF_3 producers. Known consumer and distributor stocks totaled about 105,000 t, which included 75,200 t at consumer or distributor facilities and 29,400 t purchased from the NDS but still located at NDS depots. As of December 31, 2004, the NDS fluorspar inventory classified as excess (excluding material sold pending shipment) contained about 83,400 t (91,900 short dry tons) of fluorspar (table 1). This total included about 4,430 t of acid grade (4,880 short dry tons) and 79,000 t of metallurgical grade (87,100 short dry tons). These numbers, particularly in the breakdown between metallurgical grade and subspecification metallurgical grade, differ from those reported in 2003, and it is assumed that the DNSC’s records were updated or reassessed.

Transportation

The United States is import dependent for the majority of its fluorspar supply. Fluorspar is transported to customers by truck, rail, barge, and ship. Metallurgical grade is shipped routinely as lump or gravel, with the gravel passing a 75-millimeter (mm) sieve and not more than 10% by weight passing a 9.5-mm sieve. Acid grade is shipped routinely in the form of damp filtercake that contains from 7% to 10% moisture to facilitate handling and to reduce dust. This moisture is removed by heating in rotary kilns or other kinds of dryers before treating with sulfuric acid to produce HF. In recent years, most acid-grade imports have come from China and South Africa and are usually shipped by ocean freight using bulk carriers of 10,000 to 50,000 t deadweight; ships in this size range are termed “handymax.” Participants negotiate freight levels, terms, and conditions. Some acid grade and ceramic grade is marketed in bags for small users and shipped by truck.

Maritime shipping rates are tracked by several different indices, which are differentiated by the size of ships included. The Baltic handymax index (BHMI) is calculated from the weighted average rates on major timecharter routes, with two trial voyage routes, as assessed by a panel of brokers. The BHMI was quite volatile in 2004; it increased sharply by about 35% during the first quarter, decreased at an even faster rate by about 54% in the second quarter, and then increased by nearly 100% by early December before tailing off a bit by the end of December (Hayley-Bell, 2005).

Prices

At yearend, according to published prices, the average U.S. Gulf port price, including cost, insurance, and freight (c.i.f.), dry basis, for Chinese acid grade increased by more than 19% (table 3). The average price of standard Mexican acid-grade fluorspar [free on board (f.o.b.) Tampico] increased by more than 50%, and the price of low-arsenic acid grade increased by 27%. The South African average price for acid grade (f.o.b. Durban) increased by more than 18% (Industrial Minerals, 2004). Prices for metallurgical-grade fluorspar listed in table 3 were calculated from fourth-quarter statistics from the U.S. Census Bureau.

Foreign Trade

U.S. exports of fluorspar decreased by nearly 33% to 20,600 t from the 2003 figure (table 4). All U.S. exports were believed to be reexports of material imported into the United States or exports of material previously purchased from the NDS.

In 2004, imports for consumption of fluorspar increased by about 6% compared with those of 2003 (table 5). The leading suppliers of fluorspar to the United States were China (55%), Mexico (22%), South Africa (15%), and Mongolia (8%). The average unit value, including c.i.f., was $167 per metric ton for acid grade and $82 per ton for metallurgical grade (table 1).

Driven by the strong fluorocarbon market, imports of HF increased by about 15% to 128,000 t (table 6). Imports of synthetic and natural Na_3AlF_6 decreased by more than 52% to 3,860 t (table 7) and imports of AlF_3 decreased by more than 53% to 4,700 t (table 8).

There are no tariffs on fluorspar from normal-trade-relations countries. There are no tariffs on other major fluoride minerals and chemicals, such as natural or synthetic Na_3AlF_6, HF, and AlF_3.

World Review

Estimated world production increased by 4% compared with the revised 2003 data (table 9). The leading producers, in descending order, were China, Mexico, Mongolia, and South Africa.

Australia.—The status of the Speewah fluorite project in the East Kimberley region of northern Western Australia was unknown. The joint-venture partners (Doral Minerals Industries Ltd. and Minerals Securities Ltd.) announced in July 2004 that the need for additional drilling and increased costs had resulted in their decision to consult with potential customers on pricing and demand before continuing (Doral Mineral Industries Ltd., 2004). Normally, in the case of a mineral supplier, fluorochemical companies would require product samples for testing and significant proof of project viability before agreeing to anything. The partners were likely discouraged by the results of their consultations and have shelved the project.

China.—In 2004, the export quota for fluorspar was set at 750,000 t, and there were two rounds of bidding (January and June) for quota amounts and export license fees. As usual, the offerings were divided into two categories—agreement and open bidding. In the first round, 375,000 t was offered, which included 225,000 t offered for agreement bidding and 150,000 t offered for open bidding. The agreement bids averaged about $37 per ton, and the open bids, about $82 per ton, for a weighted average of $55 per ton. In the second round, an additional 375,000 t was offered, and the same amounts were offered for agreement and open bidding. The average bids were $37 per ton (agreement) and $92 per ton (open), for a weighted average of $61 per ton. According to preliminary information, China exported 830,000 t of fluorspar in 2004.

South Africa.—South Africa's Witkop Mining (Pty.) Ltd.'s plant upgrade project essentially was completed during the summer. Significant steps included the commissioning of a new ball mill in April and the commissioning of another ball mill and a regrind mill in June. Mine and plant improvements were expected to increase production capacity to 180,000 metric tons per year (t/yr) from 110,000 t/yr.

Since the end of 2001, the rand has strengthened significantly against the U.S. dollar. If the rand continues to appreciate against the dollar, Witkop reported that it had a contingency plan to reduce costs that would involve recycling of tailings to recover fluorspar. Witkop has an estimated 45 million metric tons of tailings material (containing about 6% CaF_2) that could be considered for recycling. This recycling plan would supplement mine production. If a decision to implement such a recycling plan were made, then it could be underway in a reasonably short time (Mining Review, 2004§).

Thailand.—SC Mining Co. Ltd. is mining tungsten from the Doi Ngom deposit in Amphoe [District] Long, Changwat [Province] Phrae in northern Thailand. The deposit comprises primarily the tungsten ore ferberite ($FeWO_4$) but contains fluorite as an accessory mineral in the uppermost part of the ore body. In the past, this material was regarded simply as overburden in the mining of the tungsten. Examination of the overburden over roughly one-third of the deposit's length established that this material contained a minimum of 400,000 t of fluorspar grading 50% CaF_2. The company was evaluating the potential of local markets for metallurgical-grade fluorspar. The company's current plan would include facilities for the monthly production of 5,000 t of metallurgical grade for the local market and 3,000 t of acid grade for export. Once a decision has been made to proceed, production of metallurgical grade could begin within a month. Production of acid grade, however, would require construction of a flotation mill, and the company would only consider such a venture with the involvement of a partner with experience in the fluorspar business (Industrial Minerals, 2005).

United Kingdom.—Glebe Mines Ltd., the primary fluorspar producer in the United Kingdom, has been working with the University of Leicester to develop new exploration techniques to locate fluorspar deposits. The traditionally mined vein deposits have been largely depleted, but "replacement deposits," which formed where the host limestones have been replaced by fluorite and barite, may still be available for mining. The limited understanding of the geologic controls of these types of deposits meant that no effective exploration methodology existed.

The project first involved taking a large volume of historical data from Glebe's previous excavations and importing this into a specially developed geographic information system. This allowed scientists at Leicester to use scientific principles to identify how and where replacement ore deposits could occur. The second element introduced geophysical techniques to reduce the amount of test drilling and trenching that Glebe had to undertake on a new site. Glebe has been introducing these techniques to its new open cast sites, and the system has already assisted in locating a major ore body (University of Leicester, 2004§).

Vietnam.—Tiberon Minerals Ltd. announced completion of a positive interim feasibility study for the Nui Phao tungsten-fluorspar project in Vietnam. The study indicated that the development would be economic. The new project plan forecasted production of about 220,000 t/yr of acid-grade fluorspar, about 4,300 t/yr of tungsten concentrate, and additional small tonnages of bismuth, copper, and gold. Projected operating costs for the operation remained low, but the capital cost of the project rose to $211 million compared with a prefeasibility study 2 years ago that had put the forecast total at $140 million. Tiberon management attributed the increase to a number of factors, which included about $25 million in compensation and resettlement costs (which were not in the original estimate), $3.5 million for a dedicated bismuth recovery plant (not in the previous study), and a general rise in construction and fuel costs in the 2 years since the previous study. A final feasibility study was expected to be completed by the end of June 2005 (Mining Journal, 2005). Tiberon Minerals holds a 77.5% interest in the Nui Phao Joint Venture Mining Company Ltd.; the remaining 22.5% is held by two Vietnamese minority partners.

Outlook

Demand for acid-grade fluorspar is expected to remain strong in North America because of growing demand for fluorocarbon-base refrigerants. The continued growth in the fluoropolymer and fluoroelastomers markets also will contribute to strong demand. With HF producers DuPont and Honeywell operating their plants at high-capacity rates, supplies of fluorspar will be supplemented by large amounts of imported HF. In 2004, HF imports of 128,000 t were equivalent to more than 280,000 t of fluorspar.

China announced that it would maintain its 2005 export quota for fluorspar at 750,000 t/yr. The average export license fee continued to rise driven by a dramatic increase in the open bidding price, which averaged about $125 per ton. The average agreement bid decreased to $27 per ton, but the overall average increased to $66 per ton. Additional upward price pressures were applied when the Chinese Ministry of Finance announced plans to eliminate the 5% export rebate on fluorspar effective May 1, 2005. These factors will result in higher Chinese fluorspar prices in 2005, especially for acid-grade fluorspar. Prices for acid grade from other major exporting countries, such as Mexico, Mongolia, and South Africa, likely will increase. South African price increases have lagged behind those of other producing countries in recent years because about one-third of its sales were capped on the basis of a 5-year old supply contract with one of the major fluorochemical companies. This contract was being renegotiated, and prices for South African acid-grade fluorspar are expected to increase significantly.

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TABLE 1

SALIENT FLUORSPAR STATISTICS[1, 2]

		2000	2001	2002	2003	2004
United States:						
Exports:[3]						
Quantity	metric tons	39,800	21,200	24,300	30,700	20,600
Value[4]	thousands	$5,330	$3,250	$3,540	$4,610	$3,200
Imports:[3]						
Quantity	metric tons	523,000	522,000	494,000	567,000	599,000
Value[5]	thousands	$65,200	$69,000	$62,000	$76,300	$95,300
Average value:[5]						
Acid grade	dollars per metric ton	127.98	134.90	127.70	138.00	167.00
Metallurgical grade	do.	84.25	80.04	88.66	85.00	82.00
Consumption:						
Reported	metric tons	512,000	536,000	588,000	616,000	673,000
Apparent	do.	601,000 [6]	543,000 [7]	477,000 [7]	589,000 [8]	691,000 [8]
Stocks, December 31:						
Consumer and distributor[9]	do.	289,000	221,000	245,000	206,000	105,000
Government stockpile	do.	112,000	112,000	109,000	95,000	83,400
World, production	do.	4,450,000 [r]	4,590,000 [r]	4,440,000 [r]	4,860,000 [r]	5,060,000 [e]

[e]Estimated. [r]Revised.

[1]Data are rounded to no more than three significant digits.

[2]Does not include fluorosilicic acid production or imports of hydrofluoric acid and cryolite.

[3]Source: U.S. Census Bureau; may be adjusted by the U.S. Geological Survey.

[4]Free alongside ship values at U.S. ports.

[5]Cost, insurance, and freight values at U.S. ports.

[6]Imports minus exports plus adjustments for Government and industry stock changes.

[7]Imports minus exports plus adjustments for changes in stocks held by Government and three leading consumers.

[8]Imports minus exports plus adjustments for changes in stocks held by distributors, Government, and leading consumers.

[9]Includes fluorspar purchased from the National Defense Stockpile (NDS) but still located at NDS depots.

TABLE 2

U.S. REPORTED CONSUMPTION OF FLUORSPAR, BY END USE[1]

(Metric tons)

	Containing more than 97% calcium fluoride		Containing not more than 97% calcium fluoride		Total	
End use or product	2003	2004	2003	2004	2003	2004
Hydrofluoric acid and aluminum fluoride	523,000	586,000	--	--	523,000	586,000
Metallurgical	20,400	20,400	43,100	39,400	63,500	59,700
Other[2]	29,100	26,400	--	--	29,100	26,400
Total	573,000	633,000	43,100	39,400	616,000	673,000
Stocks, consumer, December 31[3]	99,200	59,500	26,800	15,700	126,000	75,200

-- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Includes acid grade used in enamel, glass and fiberglass, steel castings, and welding rod coatings.

[3]Stocks are from hydrofluoric acid and aluminum fluoride producers and major distributors.

TABLE 3
PRICES OF IMPORTED FLUORSPAR

(Dollars per metric ton)

Source and grade	2003	2004
Chinese, dry basis, cost, insurance, and freight (c.i.f.) Gulf port, acidspar filtercake	165-170	195-205
Mexican, free on board (f.o.b.) Tampico, acidspar filtercake	105-125	168-178
Mexican, f.o.b. U.S. Gulf port, arsenic less than 5 parts per million	141-150	180-190
Mexican, c.i.f. port of U.S. entry, metspar[1]	85	83
South African, f.o.b. Durban, acidspar	105-125	128-145

[1]Metspar prices are the average value per metric ton of imported Mexican metspar for the fourth quarter calculated from the U.S. Census Bureau statistics.

Sources: Industrial Minerals, no. 435, p. 79, December 2003; no. 446 [447], p. 72, December 2004.

TABLE 4

U.S. EXPORTS OF FLUORSPAR, BY COUNTRY[1]

Country	2003 Quantity (metric tons)	2003 Value[2]	2004 Quantity (metric tons)	2004 Value[2]
Canada	24,000	$3,610,000	13,700	$2,100,000
China	100	28,800	713	127,000
Dominican Republic	468	70,500	308	52,400
Mexico	86	12,100	--	--
Taiwan	5,720	827,000	5,550	834,000
Other[3]	270	57,600	401	85,800
Total	30,700	4,610,000	20,600	3,200,000

-- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Free alongside ship values at U.S. ports.

[3]Includes Australia, The Bahamas, Denmark, Japan, the Republic of Korea, the Netherlands Trinidad and Tobago, and Venezuela.

Source: U.S. Census Bureau.

TABLE 5

U.S. IMPORTS FOR CONSUMPTION OF FLUORSPAR, BY COUNTRY AND CUSTOMS DISTRICT[1]

Country and customs district	2003 Quantity (metric tons)	2003 Value[2] (thousands)	2004 Quantity (metric tons)	2004 Value[2] (thousands)
Containing more than 97% calcium fluoride (CaF_2):				
China:				
Houston, TX	227,000	$34,100	151,000	$28,800
New Orleans, LA	109,000	14,900	179,000	30,300
Total	336,000	49,000	330,000	59,200
France, Philadelphia, PA	82	27	66	24
Germany, Savannah, GA	17	11	19	9
Mexico:				
Houston, TX	--	--	16,000	2,920
Laredo, TX	33,400	4,820	31,000	5,110
New Orleans, LA	23,000	2,070	32,400	4,060
Total	56,300	6,890	79,300	12,100
Mongolia:				
Baltimore, MD	20	3	--	--
Houston, TX	--	--	10,800	1,570
New Orleans, LA	--	--	38,300	6,120
Total	20	3	49,200	7,690
South Africa:				
Houston, TX	9,890	1,130	23,500	3,080
New Orleans, LA	111,000	13,700	64,000	8,830
Total	120,000	14,900	87,400	11,900
Spain, New Orleans, LA	19,100	2,540	--	--
United Kingdom:				
Cleveland, OH	1	2	--	--
Houston, TX	--	--	1	4
Los Angeles, CA	445	53	507	60
New York, NY	108	37	12	18
Philadelphia, PA	1	7	--	--
Total	555	99	520	82
Grand total	533,000	73,400	546,000	91,000
Containing not more than 97% CaF_2:				
Mexico:				
Buffalo, NY	--	--	13	5
Laredo, TX	1,130	123	1,100	120
New Orleans, LA	32,700	2,750	50,000	4,100
Total	33,800	2,870	51,100	4,230
Venezuela, Virgin Islands	--	--	1,880	102
Grand total	33,800	2,870	53,000	4,330
Grand total imports all grades	567,000	76,300	599,000	95,300

-- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Cost, insurance, and freight values at U.S. ports.

Source: U.S. Census Bureau; may be adjusted by the U.S. Geological Survey.

TABLE 6

U.S. IMPORTS FOR CONSUMPTION OF HYDROFLUORIC ACID, BY COUNTRY[1]

	2003		2004	
Country	Quantity (metric tons)	Value[2] (thousands)	Quantity (metric tons)	Value[2] (thousands)
Canada	33,900	$38,600	45,500	$48,700
China	951	567	950	661
France	36	41	--	--
Germany	476	834	261	540
Italy	19	24	38	58
Japan	1,140	2,780	1,370	3,310
Korea, Republic of	70	261	123	416
Mexico	74,800	71,500	79,500	76,200
Netherlands	24	99	58	245
Other[3]	98 r	234 r	193	402
Total	111,000	115,000	128,000	131,000

[r]Revised. -- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Cost, insurance, and freight values at U.S. ports.

[3]Includes India, Singapore, Spain, Switzerland, Taiwan, and the United Kingdom.

Source: U.S. Census Bureau; adjusted by the U.S. Geological Survey.

TABLE 7

U.S. IMPORTS FOR CONSUMPTION OF CRYOLITE, BY COUNTRY[1]

	2003		2004	
Country	Quantity (metric tons)	Value[2] (thousands)	Quantity (metric tons)	Value[2] (thousands)
China	510	$392	647	$529
Denmark	239	417	323	525
Germany	1,710	1,350	1,970	1,820
Hungary	368	376	294	293
Italy	4,510	3,160	--	--
United Arab Emirates	492	180	--	--
Other[3]	292 r	234 r	630	492
Total	8,120	6,120	3,860	3,660

[r]Revised. -- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Cost, insurance, and freight values at U.S. ports.

[3]Includes Belgium, France, Hong Kong, India, Japan, Mexico, Turkey, and the United Kingdom.

Source: U.S. Census Bureau.

TABLE 8

U.S. IMPORTS FOR CONSUMPTION OF ALUMINUM FLUORIDE, BY COUNTRY[1]

Country	2003 Quantity (metric tons)	2003 Value[2] (thousands)	2004 Quantity (metric tons)	2004 Value[2] (thousands)
Canada	2,700	$2,090	1,660	$1,500
Italy	2,400	1,630	--	--
Mexico	4,830	3,790	2,950	2,060
Other[3]	150 r	141 r	90	185
Total	10,100	7,640	4,700	3,750

[r]Revised. -- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Cost, insurance, and freight values at U.S. ports.

[3]Includes China, Japan, and the United Kingdom.

Source: U.S. Census Bureau.

TABLE 9

FLUORSPAR: WORLD PRODUCTION, BY COUNTRY[1, 2]

(Metric tons)

Country and grade[3, 4]	2000	2001	2002	2003	2004[e]
Argentina	11,229	9,075	5,168	5,530	5,600
Brazil, marketable:					
Acid grade	30,131	31,263	32,774	33,000 r	33,000
Metallurgical grade	12,831	12,471	15,125	15,100 r	17,000
Total	42,962	43,734	47,899	48,100 r	50,000
China:[e]					
Acid grade	1,250,000	1,250,000	1,250,000	1,300,000	1,300,000
Metallurgical grade[5]	1,200,000	1,200,000	1,200,000	1,350,000	1,400,000
Total	2,450,000	2,450,000	2,450,000	2,650,000	2,700,000
Egypt[e]	500	500	500	500	500
France:[e]					
Acid and ceramic grades	85,000 r	90,000	90,000	79,000 r	80,000
Metallurgical grade	20,000	20,000	15,000	10,000 r	10,000
Total	105,000 r	110,000	105,000	89,000 r	90,000
Germany[e]					
Acid grade	29,600	29,400	33,400	32,300	32,000
Metallurgical grade	1,500	1,000	1,000	1,000	1,000
Total	31,100 r	30,400 r	34,400 r	33,300 r	33,000
India:[6]					
Acid grade	3,782 r	6,900	4,198	4,200 e	4,300
Metallurgical grade	3,253 r	13,866	6,296	6,300 e	6,400
Total	7,035	20,766	10,494	10,500 e	10,700
Iran[7]	20,000 e	35,986	32,006	32,000 e	32,000
Italy:[e]					
Acid grade	50,000	30,000	30,000	30,000	30,000
Metallurgical grade	15,000	15,000	15,000	15,000	15,000
Total	65,000	45,000	45,000	45,000	45,000
Kenya, acid grade	100,102	118,850	85,015	95,278 r	108,000
Korea, North, metallurgical grade[e]	25,000	25,000	25,000	25,000	25,000
Kyrgyzstan	3,000 e	1,175	2,750 e	3,973	4,000
Mexico:[8]					
Acid grade	334,780	343,486	343,332	409,122 r	458,000
Metallurgical grade	300,450	275,982	279,145	347,136 r	350,000
Total	635,230	619,468	622,477	756,258 r	808,000
Mongolia:					
Acid grade	111,443	127,000	86,000	120,000 r, e	105,000
Other grades[9]	87,400	72,000	99,000	155,000 r, e	190,000
Total	198,843	199,000	185,000	275,000 r, e	295,000
Morocco, acid grade	76,991	96,500	94,911	81,225	81,000
Namibia, acid grade[10]	66,128	81,245	81,084	79,281	104,767 [11]
Pakistan, metallurgical grade[e]	997 [11]	1,000	1,000	1,000	1,000
Romania, metallurgical grade[e]	15,000	15,000	15,000	15,000	15,000
Russia	187,600	200,000	169,000	170,000 e	170,000
South Africa:[12]					
Acid grade	201,737	272,844	215,650	221,000 r	260,000
Metallurgical grade	10,618	13,156	11,350	14,000 r	15,000
Total	212,355	286,000	227,000	235,000	275,000
Spain:					
Acid grade	132,690 r	126,535 r	131,155 r	129,195 r	130,000
Metallurgical grade	7,776 r	7,504 r	10,279 r	10,503 r	10,000
Total	140,466 r	134,039 r	141,434 r	139,698 r	140,000
Tajikistan[e]	9,000	9,000	9,000	9,000	9,000
Thailand, metallurgical grade	4,745	3,020	2,271	2,368 r	2,375 [11]

See footnotes at end of table.

TABLE 9—Continued

FLUORSPAR: WORLD PRODUCTION, BY COUNTRY[1, 2]

(Metric tons)

Country and grade[3, 4]	2000	2001	2002	2003	2004[e]
Turkey, metallurgical grade	4,113	4,093	5,344	718 [r]	500
United Kingdom[e]	35,000	50,000	45,000	60,000	60,000
Grand total	4,450,000 [r]	4,590,000 [r]	4,440,000 [r]	4,860,000 [r]	5,060,000

[e]Estimated. [r]Revised.

[1]World totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.

[2]Table includes data available through June 6, 2005.

[3]In addition to the countries listed, Bulgaria is believed to have produced fluorspar in the past, but production is not officially reported, and available information is inadequate for the formulation of reliable estimates of output levels.

[4]An effort has been made to subdivide production of all countries by grade (acid, ceramic, and metallurgical). Where this information is not available in official reports of the subject country, the data have been entered without qualifying notes.

[5]Includes submetallurgical-grade fluorspar used primarily in cement that may account for 33%.

[6]Year beginning April 1 of that stated.

[7]Year beginning March 21 of that stated.

[8]Data are reported by Consejo de Recursos Minerales, but the production of metallurgical and acid grades has been redistributed on the basis of industry data.

[9]Principally submetallurgical-grade material.

[10]Data are in wet tons.

[11]Reported figure.

[12]Based on data from the South African Minerals Bureau; data show estimated proportions of acid-, ceramic-, and metallurgical-grade fluorspar within the reported totals.